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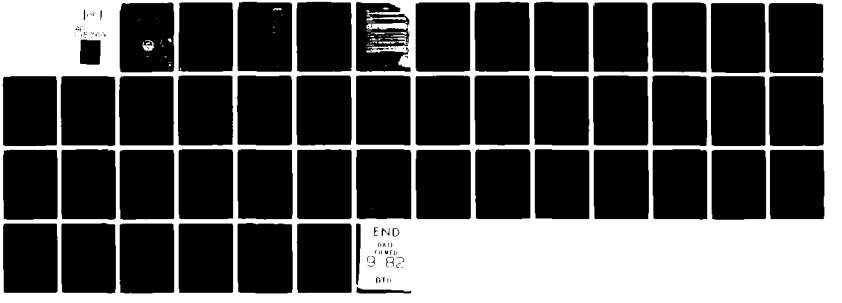

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ESTABLISHING RELATIVE COSTS IN A COMPLEX TRAINING SYSTEM: A COST ASSESSMENT MODEL AND ITS APPLICATION IN THE P-3 FLEET READINESS SQUADRON AIRCREW TRAINING SYSTEM

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NPRDC Special Report 82-32 August 1982

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Training system decisions are often made without a complete understanding of the impact on system costs. This report describes a model that can be used to estimate and compare the costs of training system components and of potential changes to the components. The model is intended for use by managers of complex training systems who are contemplating system changes. The cost assessment model is presented, and is then applied to data available from the P-3 fleet readiness squadron (FRS) aircrew training system.

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FOREWORD

This effort was part of a program sponsored by the Chief of Naval Operations (OP-594) and the Naval Air Systems Command (AIR-4133E). Some of the work was carried out under contract with Courseware, Inc. The overall objective of the program was to develop a new P-3 fleet readiness squadron (FRS) aircrew training system.

This report describes a training model that can be used to predict the costs of changes to training systems. The use of the model has been illustrated by applying it to the P-3 FRS aircrew training system. The model is intended for use by managers of complex training programs who are contemplating revisions to their syllabi. The data used to illustrate the model show the relative costs of P-3 FRS aircrew training categories and should be of interest to P-3 training system managers. Related reports described the applicability of computer-assisted instruction to P-3 aircrew training (NPRDC Special Report 82-18), the use of a subset of P-3 training objectives in evaluating media selection procedures (NPRDC Special Report 82-13), and the instructional systems development procedures used in the revision of P-3 FRS aircrew training (NPRDC Technical Report 82-51).

Appreciation is expressed to the staffs of Commander Naval Air Force, U.S. Pacific Fleet; Commander Patrol Wings, U.S. Pacific Fleet; Commanding Officer, Fleet Aviation Specialized Operational Training Group Pacific; and especially Commanding Officer, Patrol Squadron 31, for assistance in the development of the model that is described in this report. Particular thanks are due to LCDR Diane Pope, USNR; WING CDR Darrell Simpson, Royal New Zealand Air Force; and Dr. W. M. Swope, of the Naval Training Equipment Center.

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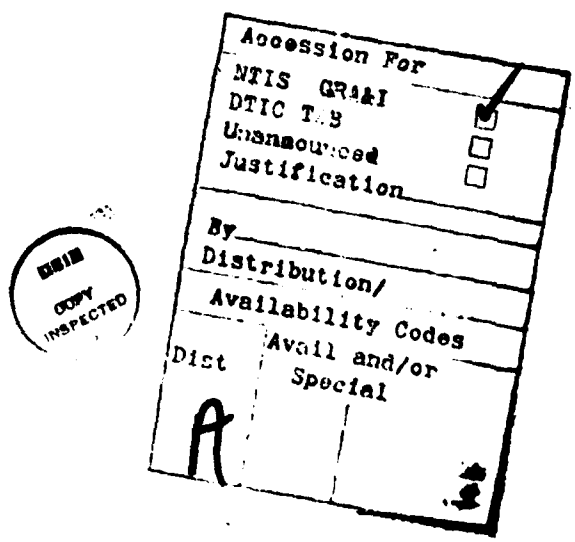

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INTRODUCTION

Problem

Managers of complex training systems frequently make decisions that result in changes to existing syllabi. In many instances, these decisions are made without a complete understanding of the cost impact of the changes. Training managers often have cognizance of only a small part of the costs of training. Historically, the most readily available cost data have been those associated with the procurement and routine operation of the system hardware (aircraft, training devices, etc.). Other readily available cost data, particularly in recent years, are those associated with developing new training syllabi using the instructional systems development (ISD) process. Typically, when costs are considered, only the most visible costs are used and many others that are not so easily documented are ignored.

Objective

The objective of this effort was to develop a cost assessment model that would allow training course managers to estimate the potential cost impact of decisions affecting the syllabus.

Background

Training system managers are seldom able to relate the cost of course development or revision to the cost of the entire training system. They often point to the high cost of training, but are unable to identify or compare cost categories or describe the interrelationships between them. ISD costs are often quoted, but the figures quoted can seldom be related to other costs within the training system because it has been difficult to identify training system cost categories and determine the cost ramifications of changes within them.

Numerous cost studies and/or models are available, but each has shortcomings in the areas of training system cost assessment and comparison, particularly with respect to fleet level use. Doughty, Stern, and Thompson (1976) have developed a guideline for cost analysis in a typical U.S. Navy Class "A" school, but their study does not adequately reflect the ISD acquisition costs or the costs relevant to the more exotic hands-on media such as flight simulators. They also do not cover multiple training tracks or the interaction of training tracks with the media used for training aircrews. Orlansky and String (1977) present a rather complete generalized model for estimating training costs. However, they do not apply the model in a complete manner to a specific Navy training setting. Allbee and Semple (1980) have developed an extensive cost model using various U.S. Air Force examples. However, the Allbee and Semple model cannot be applied directly to Navy training because of the differences between Air Force and Navy cost accounting methods. While the Allbee and Semple model does render valuable insights into the development of cost models, its approach is often too detailed for use by individual Navy training activities that may lack the required accounting resources.

Existing models that are suitable for fleet level use are too limited in their scope. Browning, Ryan, Scott, and Smode (1977) were not tasked to look at any training medium except a particular flight simulator and did not make comparisons beyond one training track. Braby, Henry, Parrish, and Swope (1975) provided some guidelines for costing media alternatives, but these guidelines are helpful only in isolating costs of conventional media. Goclowski, King, Ronco, and Askren (1978) described a model identifying system ownership costs. Their model is a good reference in attempting to establish a

methodology for the identification of cost-related factors in a complex training system, but it is incomplete in other areas. A model for costing a complex training system is needed that will allow meaningful comparisons to be made among categories of costs within the system.

Use of the Model

The present work is not a new approach to cost analysis but represents a modification of existing models to make them usable in fleet readiness squadrons (FRSs), functional wings, type commands, and other organizations concerned with complex Navy training systems. It is recognized that the model to be presented here is not an optimization model but simply provides a structured means for determining costs of specific training scenarios. No systematic attempt has been made to adhere to the Department of Defense (DoD) requirements for conducting economic analyses,[1] since this model is intended for use by training managers in the fleet who are not usually in a position to follow those exacting guidelines, but who nevertheless require assistance in assessing the relative costs involved in training system decisions they must make.

An overview of the cost model will be presented to familiarize the user with the cost categories included. Each category will then be discussed and cautions will be given with respect to its use. Finally, an application of the model will be presented, using data from the Navy's P-3 FRS aircrew training system.

Abbreviations and Acronyms

Abbreviations and acronyms used frequently in the remainder of this report are given below.

Acronym	Description
A/C	Aircraft
AET	Actual equipment trainer
ASW	Antisubmarine warfare
CAI	Computer-assisted instruction
Comm	Communicator
FASOTRAGRU	Fleet Aviation Specialized Operational Training Group
FE	Flight engineer
FRS	Fleet readiness squadron
ISD	Instructional systems development
LC	Learning center
MCS	Master course syllabus
NFO	Naval flight officer
OFT	Operational flight trainer
Ord	Ordnanceman
P-3, P-3B, P-3C	Land-based ASW fixed-wing aircraft
POL	Petroleum, oil, and lubricants
PT	Position trainer
S-3, S-3A	Carrier-based ASW aircraft

[1] Economic analysis and program evaluation for resource management (Department of Defense Instruction 7041.3). Washington, DC: Office of the Assistant Secretary of Defense (Comptroller), 18 October 1972.

SME	Subject matter expert
SS-1/2, SS-3	Sensor station operators
VP-30	Patrol Squadron 30
VP-31	Patrol Squadron 31
WST	Weapon systems trainer

DEVELOPMENT OF THE MODEL

Training Cost Model Overview

Figure 1 presents the cost model in block form. Each category has three potential cost components that may or may not apply to a particular training system: initial procurement, projected life-cycle personnel costs, and projected life-cycle nonpersonnel costs. Each of these components should be considered in a cost evaluation, even though the description of the model presented here may not specifically address all possible subcategory costs for all applications.

Generally, costs must be determined for broad cost categories, since in many cases the costs for individual courses, students, or crews are not available except by apportioning costs from the broader categories. Costs incurred from purchase of major training devices or for procurement of training courses developed using ISD methodology are not available except as an aggregate. When a grand total or subtotal is obtained, it is a relatively simple matter to parcel out unit costs.

It is imperative that all relevant baseline conditions and constraints applicable to a particular training system be explicitly stated at the outset. This will ensure understanding and agreement with respect to the outcomes of the cost determination.

Early in the application of this model to a real training situation, the analysts should prepare a set of worksheets similar to the tables in the next section, adding or deleting columns or rows as necessary for the particular application. In particular, summary worksheets should be prepared for each of the five main cost categories shown in Figure 1.

ISD Costs

The cost components of the ISD category include the initial procurement and the projected personnel and nonpersonnel costs involved in updating and maintaining the training. Since all DoD curriculum development must now be accomplished through the use of ISD techniques, attention has focused on these techniques, and the cost of curriculum development has been isolated from other training costs.

Curriculum development of any kind is expensive, although the costs of traditional techniques are not usually available for comparison. Costs, however, are relative, and seldom have ISD costs been compared to the costs of the other components of training. If the curriculum development is a completely in-house effort, accounting procedures similar to those of a complete contracted ISD effort should be established to track all relevant costs.

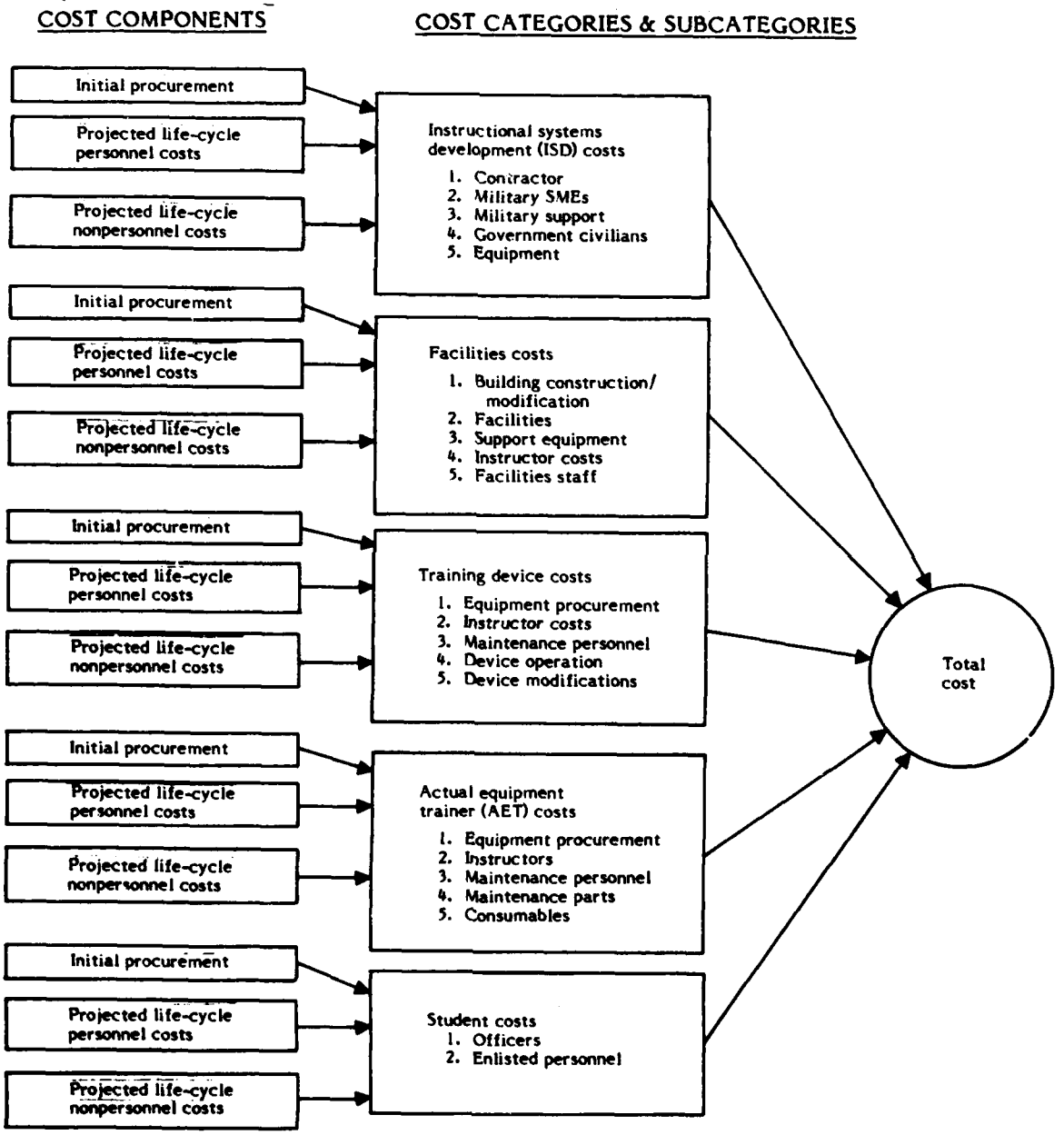

Figure 1. Typical training system cost model.

Initial Procurement of ISD

As manpower availability has decreased, the Navy has often turned to civilian contractors for curriculum development using ISD methodology. Contractor costs, since they are usually very visible, are often viewed as the major costs of ISD. When all ISD procurement cost factors have been included, the total ISD costs are often orders of magnitude larger than the costs of ISD contractors alone.

Projected Life-cycle Personnel Costs for ISD

Any assumptions made with respect to future costs must be specified, since they may have a marked effect on cost projections. When future costs are estimated, a fixed period for the projections should be chosen to represent the life cycle of the training system and this period should be applied to all cost areas in the model. The life cycle chosen should be a reasonable estimate of the longevity of the training system.

To the extent that personnel are not employed full-time in ISD activities, the projections of their costs should reflect only that percentage of their time that is spent in those activities. Personnel costs should be based on the authorized billet structure and not on the actual on-board personnel, who may change over the years. Projections of annual pay increases should be included. The effects of inflation should be included as well, unless all costs are to be calculated in dollars tied to a particular year. If inflation is ignored, relative rather than absolute costs will be the outcome. In many applications, however, relative costs of alternative configurations will be the most valuable information.

Life-cycle Nonpersonnel Costs for ISD

If new equipment is required to carry out ISD update activities or to manage and control the updating process, or if outside services are used in the maintenance of the instruction, the costs of these items should be included here. Also, costs of administrative equipment and supplies should be included.

Facilities Costs

It is difficult to be all-inclusive in the area of classroom facilities due to the complexity of the possible cost categories. Each training system will have to be considered carefully, and the model must be molded to fit the situation. The life cycle of the system must be specified, and costs projected over that life cycle.

Initial Procurement of Facilities

1. Building Costs. This item may not apply in all applications of the model, since the use of existing buildings incurs no additional costs. However, if a new facility is to be constructed or an old one modified, these costs should be included.

2. Equipment Costs. All equipment such as slide projectors, videotape equipment, specialized furniture (carrels, etc.) are to be included here. If these items existed prior to the training system revision, they may be excluded from the cost comparison.

3. Support Equipment Costs. Many commands possess their own print shops, graphics shops, audiovisual studios, and/or other support activities. If these facilities will be established as part of the introduction of a training system, or if they will be modified

or augmented as part of the effort, the costs associated with that activity should be included.

Projected Life-cycle Personnel Costs for Facilities

1. Instructor Costs. Instructors are those personnel who actually instruct students in the classroom, or who act as learning center monitors in the case of individualized instruction.

2. Staff Costs. The staff members are those who are not instructors but who support the instruction, such as printing press operators, librarians, graphics personnel, audiovisual studio personnel, etc. If these personnel spend some percentage of their time on unrelated activities, that percentage of their time should be excluded from the cost projections.

Projected Life-cycle Nonpersonnel Costs for Facilities

Nonpersonnel costs should include any items that are consumed by students and require replenishment, such as workbooks, other nonrecyclable training materials, pencils, and other supplies. Projected new support equipment, such as copiers, word processors, audiovisual equipment, etc., should be included. Maintenance fees for printing presses, and any other expenses that relate to the classroom facility during the life cycle but that are not personnel costs should be included.

Training Device Costs

A training device is defined here as a device that was designed specifically to support training. It is not actual on-the-job equipment, but is often a mock-up or replication, with special features built in for the support of training. It could be an aircraft cockpit mock-up that would be used as a cockpit procedures trainer, a computer-driven aircrew team trainer or weapon system trainer, a cutaway model of a ship, a miniaturized fleet on a maneuvering board, a CAI system, or any number of other devices used specifically for training.

Slide projectors, movie projectors, televisions, etc., are considered to be support equipment, not training equipment, and are accounted for under the heading of facilities.

Procurement of Training Equipment

Acquisition costs for training equipment should include hardware and software development. Hardware costs are often relatively low in comparison to software costs when complex computers are used. In the case of CAI systems, software costs associated with instructional development are to be included in ISD costs. All other computer software costs should be included in this category.

If the training device costs are available only as amortized costs over a period of years, the total of the amortizations should be determined and used as the acquisition costs. If the equipment in question is already available, it is acceptable to consider such equipment as "sunk costs" and exclude it from cost comparisons.

Projected Life-cycle Personnel Costs for Training Equipment

1. Instructor Costs. Instructor costs over the defined life cycle of the training system must be included here. Both military and civilian personnel costs are required.

2. Maintenance Personnel Costs. The personnel costs for maintenance can be sizable in the case of complex aircraft simulators, but will often be relatively minor. Sometimes the costs will be available only in conjunction with overall training device costs, and will be included in annual staff reports published by wing or force commanders.

Projected Life-cycle Nonpersonnel Costs for Training Equipment

1. Operating Costs. These costs include all spare parts and energy costs as well as any other routine costs of operating the devices. Also included are any software/reprogramming costs involved with the hardware systems, such as CAI systems or training devices. These costs can be substantial. Often, these figures are available from the aforementioned staff reports.

2. Modification and/or Update Costs. This is a difficult area for accurate cost determination. Often, there is a plan available that specifies planned modifications, and that provides some estimate of the costs associated with the modification. However, the data often do not cover the life cycle of the training system, and educated guesses may be the best data available.

Actual Equipment Trainer (AET) Costs

Actual Equipment Trainers (AETs) are equipments that are actually used both in the fleet and in training. They might include aircraft, artillery, ships, or any other equipment that is used both to carry out the mission and to support training. If the AETs are complex, such as aircraft, a complex and expensive maintenance system may be required to ensure their operation. If an argument can be made that the maintenance system will not change as a result of training system revisions, the costs of maintenance can be excluded.

Many training systems will not include actual equipment costs, since few systems incorporate equipment that is actually used in the fleet. Even if such equipment is employed, it can often be counted as a "sunk cost" and not included in the cost data.

Procurement of AET

If the needed items are already on board, then the costs of acquiring them may be excluded. This decision is left to the user, but the rationale for excluding these costs should be documented.

Projected Life-cycle Personnel Costs for AET Operation/Maintenance

AET personnel costs must include costs for the instructors using the AET and the support personnel who maintain it. Maintenance personnel costs may be omitted from the cost projections if the anticipated changes in the training are not expected to affect AET maintenance.

Projected Life-cycle Nonpersonnel Costs for AET Operation/Maintenance

Aircraft fuel and spare parts would be included here, as would ammunition or other ordnance expended in the use of the AET. This component should not include modifications to the AET unless the modifications are to be implemented wholly for training purposes.

Student Costs

The military services, unlike most civilian employers, pay their "employees" while they are undergoing training. This expense must be included within an instructional system's training costs. To determine this cost, the number of students who enter training during the life cycle of the instructional system is multiplied by the costs of the students. Student costs include salary, overhead, and any per diem costs incurred during training within the training system being assessed. Student costs also include expenses, both salary and overhead, that are accrued during their training up to the time of their entry into the training system being assessed (see Koehler, 1979a & 1979b).

It will be necessary to determine the length of time spent in training by each type of student and thereby allocate a proportional amount of the student's annual salary to training. It may also be useful to differentiate between the number of students who enter training and the number who complete training, since the cost of dropouts can be significant and any reduction in that number can represent a significant savings. More interest in reducing the number of dropouts may be generated when the potential cost savings are made more visible.

Other Costs

Costs that do not fit into any one of the foregoing categories should be placed in an "other" category to ensure that they are not inadvertently omitted. All training system components, categories, and subcategories should be reviewed for additional expenses that have not been included elsewhere.

Model Summary

The model presented here was conceived as a generic description of the relative costs of training systems, with the intent that individual users would be able to mold it to their own system. When all blocks of information have been completed, each cost, whether realized or projected, can be compared with the other costs in the model.

The totals from the worksheets prepared for each category should be included in a summary worksheet similar to the total P-3 Aircrew Training Costs table on page 28.

APPLICATION OF THE MODEL TO P-3 FRS AIRCREW TRAINING COSTS

This section describes the application of the cost model to the P-3 fleet readiness squadron (FRS) aircrew training system. It includes certain simplifying assumptions that will be outlined below. This application of the model follows the approach of Orlansky and String (1977) in that it ignores the timing of costs and the budget implications of program alternatives. It serves as a general structure for use by local training system managers to estimate training costs and make cost comparisons.

The P-3 FRS aircrew training system was selected to illustrate the model for two reasons. First, it is a complex training system that exercises most of the facets of the model. Second, numerous data were available to the authors concerning this system, since it had recently undergone an extensive ISD effort and many of the costs were identified.

There are two P-3 FRSs. Patrol Squadron 31 (VP-31) at the Naval Air Station (NAS) Moffett Field, California, was the command most heavily involved in the ISD effort and has been designated the ISD model manager. A parallel instructional system exists at

Patrol Squadron 30 (VP-30) at NAS Jacksonville, Florida. These squadrons provide training in specific aircraft systems operation to prospective P-3 crew members in the Pacific and Atlantic Fleets. The FRSs and their respective Fleet Aviation Specialized Operational Training Group Detachments (FASOTRAGRU DETs) each control nearly two dozen aircraft and a large variety of complex training devices and other assets. These assets are used to train over 1500 prospective aircrew members every year.

The FRSs are also responsible for training maintenance personnel. However, since maintenance training was excluded from the ISD effort, it has not been included in the present example.

Defining the Scope of the Cost Assessment

Any cost assessment must begin with a set of decisions that defines the scope of the effort. These decisions will serve both to guide the cost assessment as it proceeds and to communicate to others the scope and rationale of the cost assessment. It is always possible to uncover areas of disagreement about what should be included in an exercise of this sort. However, if the scope is defined, other interested parties can note the boundaries of one assessment in undertaking another.

The following decisions were made at the outset of the P-3 FRS aircrew training cost assessment:

1. It was deemed impractical to ascertain the small cost differences among the various models of the P-3 aircraft now in use in the FRS and in fleet squadrons. In most instances, the baseline P-3C was assumed to represent the other models, except where specific data were required for the P-3B Mod. The differences among the baseline P-3C, the P-3C Update I, and the P-3C Update II have been ignored.

2. The existence of two FRSs results in some duplication of resources for which costs must be determined, thus complicating the assessment of P-3 aircrew training costs. It is assumed that potential users will more often than not be interested in applying this model to single-sited training systems. Therefore, for the purpose of this assessment, all cost data were calculated on the basis of a single squadron only. For example, training devices are available at both FRS sites, but would not have been duplicated if only one FRS existed; thus, their costs have been calculated on the basis of a single complement of devices. In other cost areas where resources were drawn from both FRSs but would have been required even if only one FRS had been involved, the costs were totaled for both FRSs and included in the displayed data. For example, in the case of the military staffing costs during the ISD effort, the staff was drawn from both Moffett Field and Jacksonville commands. However, the total staff would still have been required even if there had been only one FRS, so it is necessary to include costs that reflect staffing at both sites.

3. Student and instructor load information has been used from one P-3 FRS only. If all student and instructor quotas were used from both VP-30 and VP-31, the relative cost of those training system components that have not been duplicated (i.e., ISD costs) would decrease. However, this duplication does not serve to illustrate the model as well as a single-sited training system does. Additionally, the costs for a single P-3 site are of interest to many commands.

4. Due to the lack of data, costs were not identified for instructor training that occurred prior to assignment to the P-3 FRS. This category is negligible in the case of the P-3 FRS. It may be more significant, however, in other applications of the model. As

more specialized instructional skills are required of instructors, the training they require will become a more significant factor in total costs.

5. To simplify the model's application, student attrition was assumed to be zero. Attrition is very low in the FRSs and is not a significant factor in training costs.

6. Nontraining flights, such as administrative flights, flights aborted due to equipment malfunctions, out-of-maintenance check flights, instructor instrument check flights, and a number of others, were not included in the flight-hour figures, even though some training may have occurred on them. Data on these flights are difficult to obtain, and the degree of student training that occurred on them was not significant.

7. Costs have not been established for second tour naval flight officers (NFOs), second tour flight engineers (FEs), naval air rework facility test pilots, or other student categories that occur rarely.

8. Administrative and headquarters costs for the FRS squadrons, wings, type commanders, and FASOTRAGRU DETs have not been included. These costs could have been estimated, but the relative costs between categories would probably remain unchanged; hence, they were ignored. Allbee and Semple (1980) provide an example of an Air Force training cost model that does include costs of some of the headquarters in the chain of command.

9. The initial procurement costs of P-3 aircraft have not been included. Although an argument for their inclusion could be made, it was felt that the aircraft are resources that would continue to be available regardless of training revisions or training cost comparisons.

10. The cost of modifying the P-3 FRS classroom complex at NAS Moffett Field was included since it was a major cost in the establishment of the revised P-3 FRS curriculum. The cost of modifying the facilities at NAS Jacksonville was not included and all other military construction costs were assumed to be zero.

11. Costs are assumed to be in constant dollars, based on the 1978-1979 time frame. It is obvious that the effects of inflation in the current environment make absolute cost data somewhat difficult to interpret. However, for the purpose of this model, relative costs across categories are more important than absolute costs. The relevant information in this cost assessment is the relative impact of costs in one category as compared to another. It is recognized that using constant dollars violates DoD guidelines (see Note 1) for carrying out cost analyses, but it was felt that total adherence to those guidelines would make the model so complex that training managers would be less likely to use the model.

12. Maintaining the P-3 curriculum is expected to require a significant effort. Over a 2-year period in the Navy's S-3A FRS training system, 22 percent of the learning objectives required change due to content, learning strategy, or media-related issues (Walker, 1978). A similar effort is projected for the P-3 FRS curriculum.

Gathering Baseline Data

To apply the cost model, baseline information on the life cycle and student load is required to establish the extent of the instructional load.

Life Cycle

A 15-year life-cycle figure has been used throughout this application of the model. Another figure might easily have been chosen, but the 15- year figure appears in other P-3 FRS data and seems reasonable.

Student Load

The determination of student quotas for use in applying the model was based on VP-31 Notice 1500.[2] The quotas are presented in Table 1. Data for one class, for 10 classes (1 year), and for 150 classes (15 years) are given.

Table 1

Projected Student Load at VP-31

Aircrew Position	Number of Students Per Class	1-year Student Load	15-year Student Load
Pilot (1st Tour)	15	150	2,250
Pilot (2nd Tour)	3	30	450
Flight Engineer	14	140	2,100
B NFO	4	40	600
C NFO	8	80	1,200
B SS-1/2	4	40	600
C SS-1/2	8	80	1,200
B SS-3	2	20	300
C SS-3	4	40	600
B Ordnance	4	40	600
C Ordnance	8	80	1,200
B Communicator	4	40	600
Total	78	780	11,700

As noted previously, no allowance was made for student attrition. If attrition were significant, it could be included by the addition to the data in Table 1 of a factor representing the rate of attrition in each crew position or track. For a more complete discussion of attrition, see Orlansky and String (1977).

Description of the P-3 Master Course Syllabus (MCS)

The P-3 Master Course Syllabus by Track (1979) describes each hour of P-3 aircrew instruction for all media and all aircrew positions. Crew positions are described by type of aircraft (P-3B or P-3C) as well as by job title. The MCS is summarized in Table 2. The number of instructional objectives for each crew position is taken from a VP-31 letter.[3]

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[2] Patrol Squadron 31 Notice 1500 of 20 Apr 1978.

[3] FMS case JA-O-BHS; P & B for P-3C ISD master course syllabus. Patrol Squadron 31 letter serial 524 of 2 Nov 1979.

Table 2

Summary of Master Course Syllabus (MCS) Hours

Crew Position	No. of Objec -tives	Syllabus Hours by Medium											P-3 Flight	
		Learning Center	2C45/ 2F69F	2F87F	2F87T	2F69T	14B44	14B40	15Z1	15E16	Static A/C	A/C Lab	Phase B	Phase C, D
Pilot (1st tour)	1,000	248	22	28	32	--	3	--	--	--	--	--	20	75
Pilot (2nd tour)	--[a]	239	9	30	32	--	--	--	--	--	--	--	15	35
FE[b]	413	265	8	36	--	--	--	--	--	--	11	--	40	64
B NFO[c]	843	252	--	--	--	69	--	--	--	--	--	21	--	70
C NFO[c]	869	386	--	--	74	--	--	--	--	--	--	27	--	54
B SS-1/2	575	236	--	--	--	32	57	--	--	--	--	20	--	36
C SS-1/2	605	229	--	--	32	--	54	--	--	--	--	35	--	30
B SS-3	298	98	--	--	--	32	--	--	9	11	--	26	--	70
C SS-3	366	154	--	--	32	--	--	36	--	--	--	25	--	70
B Ord[b]	199	44	--	--	--	--	--	--	--	--	33	18	--	24
C Ord[b]	209	40	--	--	--	--	--	--	--	--	31	15	--	24
B Comm	345	130	--	--	--	--	--	--	--	--	17	51	--	30
Total	5,722	2,321	39	94	202	133	114	36	9	11	92	238	75	582

[a]Pilot first and second tour objectives not differentiated.

[b]NAMTRADET training not included.

[c]Tactical team training not included.

Table 3 shows the instructor-to-student ratio required by various hands-on media. Further along in this cost assessment, these ratios will be used to determine instructor costs.

Table 3

Instructor/Student Ratio and Instructor Cost per Student-hour for All Forms of Instructional Media

Instructor Position & Rank/Rate	Cost per Year	Instructor/Student Ratio and Instructor Cost per Student-hour by Type of Training Medium							
		Learning Center		OFT/PT		Weapons System Trainer		P-3 Aircraft	
		Ratio	Cost/hr[a]	Ratio	Cost/hr[a]	Ratio	Cost/hr[a]	Ratio	Cost/hr[a]
Pilot (LT)	$75,347	1/18	$2.32	1/2	$20.93	1/2	$20.93	1/1	$ 41.85
NFO (LT)	29,189	1/12	1.35	1/1	16.22	1/1	16.22	1/1	16.22
FE (AD1)	28,034	1/14	1.11	1/2	7.79	1/2	7.79	1/2	7.79
SS-1/2 (AW1)	23,138	1/12	1.07	1/4	3.21	1/2	6.42	1/2	6.42
SS-3 (AW2)	18,662	1/6	1.72	1/2	5.18	1/1	10.37	1/2	5.18
Ord (AO2)	18,602	1/12	0.86	--	--	--	--	1/2	5.17
Comm (AT2)	23,622	1/4	3.28	--	--	--	--	1/2	6.57

[a]The instructor cost per student-hour was derived by dividing the instructor cost per hour by the number of students assigned to each instructor. The instructor cost per hour was obtained from Koehler (1979a, 1979b) and was based on 1800 labor hours per instructor per year.)

Another set of data that will be required is the proportion of each training flight hour that can be attributed to student training in each training track. This relationship depends both on the MCS phase and crew position. Table 4 shows the allocation of flight hours by position.

Estimating P-3 FRS Aircrew Training Costs

At this point, the cost assessment for the P-3 FRS aircrew training system begins. The major cost categories will be addressed in the order that they were presented in the introduction to the model.

Table 4

Proportion of Each Flight-hour Assignable to Each Crew Member

Crew Member	MCS Phase			
	A	B	C	D
Pilot	--	0.5	--	0.14
NFO	--	--	--	0.14
FE	--	0.5	--	0.14
SS-1/2	--	--	--	0.14
SS-3	--	--	--	0.14
Ord	--	--	--	0.14
Comm	--	--	--	0.14

ISD Costs

Since a P-3 curriculum development effort was conducted recently, the ISD costs are available. The costs are broken down into three components: initial procurement, personnel update, and nonpersonnel update costs.

1. Initial Costs of Procurement. The initial contractor costs for ISD totaled $2,948,000. The P-3 ISD team costs shown in Table 5 were developed from Welch[4] for the staffing and person-years, and by using Koehler (1979a, 1979b) for the billet costs. The research psychologist (GS-12) and educational specialist (GS-11) person-years and billet costs were taken from NAVPERSRANDCEN records.

The total ISD procurement costs include the contractor costs and the ISD team costs noted above, and a category of instructional software costs that accounts for all audiovisual services performed by the Navy and also for reproduction costs of the audiovisual productions. The source for these data is a NAVPERSRANDCEN letter.[5]

The total procurement costs determined here apply to both VP-30 and VP-31. However, since the same costs would have been required even if only one FRS had been involved, the total cost must be used. This cost is $7,962,000.

2. Personnel Update Costs. It appears that the routine updating of curriculum items has decreased as the P-3 training system has "shaken down," and that the amount of updating will continue to decrease over system's 15-year life cycle until only the changes resulting from outside influences (the revisions in equipment and reference materials upon which the curriculum is based) are being made. For purposes of this cost exercise, it is assumed that the required staff will decrease in 5-year increments. The projected yearly staff costs for the first 5 years are shown in Table 6. Similar projections are shown in Table 7 for the second 5 years, and in Table 8 for the final 5 years. This staffing plan is based on recommendations developed by Walker (1978) and on data presented in a NAVPERSRANDCEN letter.[6]

[4] Welch, J., LCDR, USN. Personal Communication. March 1980.

[5] Media production resources for P-3 ISD. Navy Personnel Research and Development Center letter serial 3301 of 23 May 1977.

[6] P-3 ISD follow-on support requirements. Navy Personnel Research and Development Center letter serial 455 of 14 Aug 1978.

Table 5

P-3 ISD Team Costs

Rank/Rate	Designation/ Rating	Person-years	Cost
Military SMEs			
0-4	1320	8	$ 270,072
0-3	1310	16	1,205,552
0-3	1320 (P-3B)	17	496,366
0-3	1320 (P-3C)	16	467,168
E-7	AD	3	95,370
E-7	AW	4	107,060
E-6	AW (B SS-3)	6	138,828
E-6	AW (C SS-3)	6	138,828
E-6	AW (SS-1/2)	17	393,346
E-6	AO	8	223,024
E-6	AD	10	280,340
E-5	AT	4	94,488
Total cost of military SMEs			3,910,442
Military Support			
E-5	DM	4	63,276
E-3	DM	6	71,100
Total cost of military support			134,376
Civilian Staff			
GS-11/12	--	13	700,000
Total			$4,744,818

Table 6

P-3 ISD Update Personnel Costs
(Years 1 Through 5)

Title (Designator)	Rank/Rate	Number of Personnel	Billet Cost	Billet Cost X.58	5-year Billet Cost
Administrative Staff					
ISD Team Director (1320)	LCDR	1	$ 33,759		
Ass't Team Director (1310)	LCDR	1	69,559		
Syllabus Director (1310)	LT	1	75,347		
Syllabus Director (1320)	LT	1	29,198		
Admin. totals			$207,863	120,561	$ 602,805
Subject Matter Experts					
B Pilot (1310)	LT	1	75,347		
C Pilot (1310)	LT	1	75,347		
B NFO (1310)	LT	3	87,594		
C NFO (1320)	LT	3	87,594		
B SS-1/2	AW1	2	46,276		
C SS-1/2	AW1	1	69,414		
B/C SS-3	AWC	1	26,765		
B SS-3	AW1	1	23,138		
C SS-3	AW1	1	23,138		
C Ordnanceman	AOC	1	34,342		
B Ordnanceman	AO1	1/2	13,939		
Flight Engineer	ADCS	1	33,933		
Flight Engineer	AD1	1	28,034		
B Communicator	AT1	1	30,689		
SME totals			655,550	380,219	1,901,095
Civilian Staff					
Educational Specialist	GS-11	1	24,200		
Writer/Editor	GS-7	1	14,600		
Civilian totals			38,800	--	194,000
Adjusted 5-year Total					$2,697,900

Table 7

P-3 ISD Update Personnel Costs
(Years 6 Through 10)

Title (Designator)	Rank/Rate	Number of Personnel	Billet Cost	Billet Cost X.58	5-year Billet Cost
Administrative Staff					
ISD Team Director (1320)	LCDR	1	$33,759		
Ass't Team Director (1310)	LCDR	1	69,559		
Syllabus Director (1320)	LT	1	29,198		
Admin. total			132,516	$76,859	$ 384,295
Subject Matter Experts					
C Pilot (1310)	LT	1	75,347		
C NFO (1320	LT	3	87,594		
SS-1/2	AW1	5	115,690		
SS-3	AWC	1	26,765		
SS-3	AW1	2	46,276		
C Ordnanceman	AOC	1	34,342		
Flight Engineer	ADCS	1	33,933		
Flight Engineer	AD1	1	28,034		
SME total			447,981	259,829	1,299,145
Civilian Staff					
Educational Specialist	GS-11	1	24,200		
Writer/Editor	GS-7	1	14,600		
Civilian total			38,800	--	194,000
Adjusted 5-year total					$1,877,440

Table 8

P-3 ISD Update Personnel Costs
(Years 11 Through 15)

Title (Designator)	Rank/Rate	Number of Personnel	Billet Cost	Billet Cost X.58	5-year Billet Cost
Administrative Staff					
ISD Team Director (1320)	LCDR	1	$ 33,759		
Syllabus Director (1310)	LT	1	75,347		
Admin. total			109,106	$63,281	$ 316,405
Subject Matter Experts					
C Pilot (1310)	LT	1	75,347		
C NFO (1320)	LT	2	58,396		
SS-1/2	AW1	2	46,276		
SS-3	AWC	1	26,765		
SS-3	AW1	1	23,138		
C Ordnanceman	AOC	1	34,342		
Flight Engineer	AD1	1	28,034		
SME total			292,298	169,533	847,665
Civilian Staff					
Educational Specialist	GS-11	1	24,200		
Writer/Editor	GS-7	1	14,600		
Civilian totals			38,800	--	194,000
Adjusted 5-year total					$1,358,070

To account for the division of military work time between ISD revision/update duties and normal military responsibilities, the military billet costs in Tables 6, 7, and 8 have been reduced by a factor of 0.58 (Footnote 6). Military members of the ISD staff were able to devote 145 working days per year to ISD revision/update duties (out of the 250 working days in a year). Other duties, flying responsibilities, and vacations accounted for the remaining days. This division of responsibilities is projected throughout the system's life cycle.

A summary of the ISD personnel costs for the VP-31/FASOTRAGRUPAC ISD update efforts over the system life cycle, from Tables 6, 7, and 8, is given below:

Years	Administrative Staff	Subject Matter Experts	Civilian Staff	Totals
1-5	$ 602,805	$1,901,095	$194,000	$2,697,900
6-10	384,295	1,299,145	194,000	1,877,440
11-15	316,405	847,665	194,000	1,358,070
Total	$1,303,505	$4,047,905	$582,000	$5,933,410

3. Nonpersonnel Update Costs. No significant costs were identified in this category. There will be some costs associated with update of curriculum items. These costs will be limited to the costs of the consumable supplies required to complete the items, since a print shop, a television studio, and all other high cost items were funded out of the initial ISD funds. The costs of paper, replacement videotape, and other such items have been included with the costs for learning center nonpersonnel support costs.

4. ISD Cost Summary. The total ISD costs were developed by adding the procurement and update costs. The summary of all costs in this category is shown as Table 9. The total ISD cost for the P-3 FRS training system at Moffett Field was $6,948,000. (In this and all other summary tables, costs have been rounded to the nearest thousand).

Table 9

ISD Costs

Cost Subcategory	Procurement Cost ($)	15-year Personnel Cost ($)	15-year Nonpersonnel Cost ($)	Total ($)
Contractor	2,948,000	--	--	2,948,000
Military Admin. Staff	--	1,304,000	--	1,304,000
Military SMEs	3,910,000	4,048,000	--	7,958,000
Military Support	134,000	--	--	1,134,000
Government Civilian	700,000	582,000	--	1,282,000
Instructional Software	270,000	--	--	270,000
Total for 2 FRSs	7,962,000	5,934,000	--	13,896,000

Facilities (Learning Center) Costs

FASOTRAGRUPAC maintains a learning center (LC) facility at Moffett Field, and both VP-31 and FASOTRAGRUPAC provide instructors to support its operations. The costs for the LC have been identified as follows.

1. Initial Procurement. The LC has 198 carrels, some of which are equipped with slide-tape or videotape equipment. The military construction (MILCON) and equipment costs incurred as part of the P-3 FRS ISD effort totaled about $600,000. The reader is referred to Allbee and Semple (1980) for a further discussion of MILCON costs.

2. LC Personnel Support Costs. The cost categories for LC support personnel are: graphics personnel, text reproduction/duplication personnel, and LC staff. The equivalent of a full-time instructor for each track is present in the LC, which is staffed by both VP-31 and FASOTRAGRUPAC. Table 10 shows the costs for instructors in the LC; the total is $4,126,047.

Table 10

Life-cycle Cost of Learning Center Instructors

Crew Position	15-year Student Load	Hours in LC per Student	Instructor Cost per Student-hour	Total
Pilot	2700	248	$ 2.32	$1,553,472
NFO	1800	386	1.35	937,980
FE	2100	265	1.11	617,715
SS-1/2	1800	236	1.07	454,536
SS-3	900	154	1.72	238,392
Ord	1800	44	0.86	68,112
Comm	600	130	3.28	255,840
Total				$4,126,047

Note. Instructor cost per student-hour is from Table 3.

Noninstructor personnel required in the LC are responsible for updating and reproducing the audiovisual and printed instructional materials and for maintaining the LC's instructional materials library. Table 11 shows the cost of the staff personnel. The life-cycle costs total $4,888,575. The costs shown here were obtained from FASOTRAGRUPAC.[7]

[7]FASOTRAGRUPAC San Diego staff members. Personal Communication. April 1980.

Table 11

Learning Center Staff Support Costs

Grade/Rate	Annual Salary	Overhead	Number of Personnel	1-year Costs	15-year Cost
Graphics					
GS-9	$ 18,739	10%	1	$ 20,613	
GS-7	15,317	10%	4	67,395	
GS-5	12,368	10%	2	27,210	
GS-4	11,054	10%	1	12,159	
Printing/Reproduction					
LI2	15,567[a]	--	3	46,701	
SN	11,848[a]	--	2	23,696	
Others					
GS-5	12,368	10%	1	13,605	
GS-4	11,054	10%	1	12,159	
GS-3	9,846	10%	1	10,831	
GS-2	8,902	10%	2	19,584	
YN2	15,347[a]	--	1	15,347	
AZ3	14,971[a]	--	1	14,971	
AA	13,878[a]	--	3	41,634	
Total				$325,905	$4,888,575

[a]Includes overhead.

FASOTRAGRUPAC routinely reports military costs in accordance with the composite standard military rate table. This table accounts for pay and allowances. However, other costs are associated with individual billets, including administrative and training costs, and these must also be considered. These additional costs, which are referred to as overhead, are included in other assessments of billet costs (Koehler, 1979a, 1979b). For instance, the costs to train a pilot are included in the billet cost of a pilot, and the training costs to produce an NFO are included in his billet costs. If the standard military rate table is used for a lieutenant, it shows yearly cost to be $24,611. Koehler (1979b) includes data for both pilot and NFO lieutenants, and indicates the billet costs as $75,347 and $29,198, respectively. More inclusive billet costs for government civilian jobs are also available (Koehler, 1980). The FASOTRAGRUPAC overhead figures for civilian personnel appear to be lower than those shown by Koehler by as much as 20 percent. However, the decision was made to use the data as they were provided.

3. Learning Center Nonpersonnel Support Costs. The FASOTRAGRUPAC 15-year budget figures for nonpersonnel related costs, including supplies and equipment costs, were determined by FASOTRAGRUPAC to be $900,000. This figure includes ISD update nonpersonnel costs such as paper, replacement videotape, and similar items.

4. Learning Center Cost Summary. Table 12 shows the total cost of the LC, including initial procurement, personnel costs, and nonpersonnel costs. The total is $10,515,000.

Table 12

Facilities Costs

Cost Subcategory	Procurement Cost	15-year Personnel Cost	15-year Nonpersonnel Cost	Total
Building Construction/ Modification	$400,000	--	--	$ 400,000
Facilities Equipment	200,000	--	--	200,000
Instructors	--	$4,126,000	--	4,126,000
Facilities Staff	--	4,889,000	--	4,889,000
Consumables	--	--	$900,000	900,000
Total	$600,000	$9,015,000	$900,000	$10,515,000

Training Device Costs

Allbee and Semple (1980) discuss in their model an elaborate method for estimating training device costs in an Air Force setting. Orlansky and String (1977) use a simpler approach to arrive at the same kinds of costs. Browning et al. (1977) estimate the costs of devices required for pilot training only. For simplicity, the form of the Orlansky and String model has been used.

1. Training Device Procurement Costs. Table 13 shows the training device procurement and operation costs. The total cost was $28,200,107.

It might be concluded that these costs should be ignored, since they are "sunk costs" and are not likely to change significantly no matter what the nature of the rest of the training system. However, in this instance, the design of the devices dictates their use to a large degree, and a change in the training system might dictate different devices with different capabilities. Thus, it seems relevant to use the costs in this assessment, especially if a comparison with an alternative configuration is planned.

The cost of operating the training devices over a 15-year period was estimated to be $17,550,150.

2. Personnel Life-cycle Operation/Maintenance Costs. The costs of instructors who teach in the P-3 training devices are shown in Table 14. These costs totaled $8,490,857 for the 15-year life cycle.

Noninstructor personnel costs are not available separately, but are given as part of the annual operation costs shown in Table 13.

Table 13

Training Device Operating and Procurement Costs

Training Device	Operation in FY79			Unit Price[b]	Procurement Cost Per Hour[c]
	Cost	Hours[a]	Cost Per Hour		
2F87F (2 each)	$ 326,083	8,756	$37	$ 4,278,760	$65
2F87T (2 each)	277,608	8,023	35	4,646,882	77
14B40	89,607	1,512	59	2,081,970	92
14B44	98,323	2,526	39	2,764,113	73
2C45	57,078	1,423	40	1,232,740	58
2F69E	321,311	3,139	102	4,270,000	91
Total	$1,170,010[d]			$28,200,107	

[a]The operating hours were reported by FASOTRAGRUPAC.

[b]Unit prices obtained from the Directory of Naval Training Devices, Chief of Naval Education and Training (CNET), 1978. Some obsolete devices are not included here due to lack of data (e.g., 15Z1, 15E16).

[c]For 15-year life cycle, based on FY79 usage rates.

[d]Total life-cycle operating cost over 15 years is $17,550,150.

Table 14

Cost of Training Device Instructors

Position	15-year Student Load	Training Device Hours Per Student[a]	Instructor Cost Per Student-hour[b]	Instructor Cost Total
Pilot (1st Tour)	2250	82	$ 20.93	$3,861,585
Pilot (2nd Tour)	450	71	20.93	668,714
B NFO	600	69	16.22	671,508
C NFO	1200	74	16.22	1,440,336
Flight Engineer	2100	44	7.79	719,796
B SS-1/2	600	121[c]	3.21	233,046
C SS-1/2	1200	118[c]	3.21	454,536
B SS-3	300	84[c]	5.18	130,536
C SS-3	600	100[c]	5.18	310,800
Total				$8,490,857

[a]Training device hours per student obtained from Table 2.

[b]Instructor cost per student-hour obtained from Table 3.

[c]Figures adjusted for different instructor/student ratios in some training devices than those given in Table 3.

3. Nonpersonnel Life-cycle Operation/Maintenance Costs. These costs are not easily obtainable as separate figures, but are included in the annual operation/maintenance costs given in Table 13.

4. Training Device Cost Summary. Table 15 shows a summary of the total costs in the training device category. The final cost is $54,241,000.

Actual Equipment Trainer (AET) Costs

In this category, the costs of using the P-3 aircraft as an AET, both in the air and on the ground, are given.

1. Procurement Costs. The initial cost of the aircraft is obviously the main cost in this category. Various references are available for the initial aircraft cost. One reference (Orlansky & String, 1977) shows procurement cost per P-3 aircraft to be $8,280,000. This figure, multiplied by the number of VP-31 aircraft, would give the procurement cost. As noted earlier, however, these costs will be ignored in applying this model, since the procurement has already occurred, and the costs will be the same whether or not the instructional system is revised. (It is conceivable that a decision to remove aircraft from an FRS could be made with data showing that instruction could occur with fewer aircraft, but a decision of this kind is viewed as extremely unlikely.)

Table 15

Training Device Costs

Cost Subcategory	Procurement Cost	15-year Personnel Cost	15-year Nonpersonnel Cost	Total
Equipment Procurement	$28,200,000	--	--	$28,200,000
Instructors	--	$ 8,491,000	--[a]	8,491,000
Maintenance Personnel	--	17,550,000	--	17,550,000
Operation	--	--[a]	--	--
Modification /Update	--	--	--	--
Spare Parts	--	--	--[a]	--
Total	$28,200,000	$26,041,000	--	$54,241,000

[a]All training device maintenance and operation expenses are included under maintenance personnel expenses.

2. Personnel Operation/Maintenance Costs. Two main categories of costs would normally be included here: the costs of instructors who use the aircraft as an instructional medium and the costs for aircraft maintenance personnel. Data for instructors are given in Table 16, and these costs total $16,445,000 for the life cycle.

Costs for P-3 maintenance personnel are not easily obtainable, but it is likely that these costs will not differ markedly no matter what the instructional system looks like. Thus, they have been ignored.

3. Nonpersonnel Operation/Maintenance Costs. The cost per hour for the P-3C aircraft was determined from the NALCOMIS report.[8] The total annual flying hours for the P-3C for 1979 was determined to be 104,863. The total aircraft support costs, less training support and less petroleum, oil, and lubricants (POL), were estimated to be $155,257,000. This figure, divided by the number of annual flight hours, results in a per hour operation/maintenance cost without POL of $1,480. This is the best estimate available for cost per hour of a P-3C aircraft used on the ground as an aircraft lab. The cost of POL is $951 per flight hour.[9] The total cost per flight hour is the sum of the two figures, or $2,431.

[8]Total Support System Report (NALCOMIS Report-OTS/VAMOSE-AIR). Washington, DC: Naval Air Systems Command, 1979

[9]POL costs per hour: FY 1980. Commander Naval Air Forces, U.S. Pacific Fleet. February 1980.

Table 16

Cost of Instructors Who Use the Aircraft as an Instructional Medium

Instructor Position	15-year Student Load	Hours in Aircraft Per Student	Instructor Cost Per Student-hour	Instructor Cost Total
Pilot (1st Tour)	2250	95	$41.85	$ 8,945,438
Pilot (2nd Tour)	450	50	41.85	941,625
B NFO	600	91	16.22	885,612
C NFO	1200	81	16.22	1,576,584
Flight Engineer	2100	115	7.79	1,881,285
B SS-1/2	600	56	6.42	215,712
C SS-1/2	1200	65	6.42	500,760
B SS-3	300	96	5.18	149,184
C SS-3	600	95	5.18	295,260
B Ordnance	600	75	5.17	232,650
C Ordnance	1200	70	5.17	434,280
B Communicator	600	98	6.57	386,316
Total				$16,444,706

Notes. Hours in aircraft per student are from Table 2. Instructor costs per student-hour are from Table 3.

Table 17 gives the total number of hours that the aircraft will be used as a ground lab over the 15-year life cycle, 133,100. When this figure is multiplied by the P-3 nonflight operation/maintance cost of $1,480 per hour, the total 15-year aircraft lab cost is $167,388,000. A case could be made that this cost is too high. However, any reduction in the cost of using the aircraft as a lab would cause a similar increase in the cost of its use as an inflight AET.

Table 17

Cost of Using the Aircraft as a Lab

Position	15-year Student Load	A/C Lab Hours Per Student	Proportion of A/C Lab-hr/Student	15-year A/C Lab-Hours	15-year Aircraft Lab Cost
Pilot	--	--	--	--	
B NFO	600	21	1.0	12,600	
C NFO	1200	27	1.0	32,400	
Flight Engineer	--	--	--	--	
B SS-1/2	600	20	0.5	6,000	
C SS-1/2	1200	35	0.5	21,000	
B SS-3	300	26	0.5	3,900	
C SS-3	600	25	0.5	7,500	
B Ordnance	600	18	0.5	5,400	
C Ordnance	1200	15	0.5	9,000	
B Communicator	600	51	0.5	15,300	
Total				113,100	$167,388,000

Notes. The aircraft lab-hours per student are from Table 2. The proportions of the aircraft lab hours assignable to each student category are from Table 4. The cost per hour for using the aircraft as a lab is $1,480.

Table 18 gives the number of hours the aircraft will be used for inflight training, 146,541. When this figure is multiplied by the inflight operating cost of $2,431 per hour, the total life-cycle aircraft flight costs is $356,241,000.

Table 18

Cost of Using the Aircraft as an In-flight Actual Equipment Trainer

Position	15-year Student Load	Flight Hours Per Student	Proportion of Flight-hr/Student	15-year A/C Flight Hours	15-year Flight Cost
Pilot (1st Tour)					
Phase B	2250	20	0.50	22,500	
Phases C, D	2250	75	0.14	23,625	
Pilot (2nd Tour)					
Phase B	450	15	0.50	3,375	
Phases C, D	450	35	0.14	2,205	
B NFO	600	70	0.14	5,880	
C NFO	1200	54	0.14	9,072	
Flight Engineer:					
Phase B	2100	40	0.50	42,000	
Phases C, D	2100	64	0.14	18,816	
B SS-1/2	600	36	0.14	1,680	
C SS-1/2	1200	30	0.14	5,880	
B SS-3	300	70	0.14	1,092	
C-SS-3	600	70	0.14	2,100	
B Ordnance	600	24	0.14	1,512	
C Ordnance	1200	24	0.14	2,520	
B Communicator	600	30	0.14	4,284	
Total				146,541	$356,241,171

Notes. The flight hours per student are from Table 2. The proportions of flight hours assignable to each student category are from Table 4. The inflight operating cost is $2,431 per hour.

The total cost of the two kinds of aircraft usage is $523,629,000. Again, a case can be made that these costs are not relevant to comparative training system costs, since they do not vary significantly with training system changes. However, the aircraft use might well change with training system revisions. For this reason, these costs are included.

4. AET Cost Summary. The total AET costs are shown in Table 19. The total cost is $540,074,000.

Table 19

Actual Equipment Trainer (AET) Costs

Cost Subcategory	Procurement Cost	15-year Personnel Cost	15-year Non-Personnel Cost	Total
Equipment Procurement[a]	--	--	--	--
Instructors	--	$16,445,000	--	$ 16,445,000
Operation & Maintenance[b]	--	--	$523,629,000	523,629,000
Total	--	$16,445,000	$523,629,000	$540,074,000

[a]Aircraft procurement costs were not included in this application of the cost assessment model.

[b]Aircraft maintenance included both personnel and nonpersonnel costs.

Student Costs

Life-cycle student costs were obtained by multiplying the life-cycle student load in each category by the annual billet cost (Koehler, 1979a, 1979b) and multiplying that figure by the proportion of the year spent in training. For example, a first-tour pilot is assumed to be an ensign, and his track length is 99 days out of 250 instructional days available in a year. The cost for first year pilots is then the annual billet cost of one pilot, times 99/250ths of a year, times the number of first-tour pilots trained in the 15-year life cycle. In the P-3 example, eight student categories have been determined: They are the seven referred to in Table 4 plus an additional category for second tour pilots. Table 20 shows the data and provides a student cost figure. The life-cycle student cost is $104,048,000.

Other Costs

No other costs were determined for the P-3 FRS aircrew training example.

Summary

The data collected here include all of the relevant costs for P-3 FRS aircrew training. The total costs across all categories are shown in Table 21. The total P-3 FRS aircrew training system lift-cycle cost is estimated to be $715,826,000. Note that the definition of scope noted at the outset of this exercise has played a significant role in the final dollar amount. If a different scope were chosen, the outcome could be substantially different. For any system with the same scope, however, direct comparisons of cost should be possible from one configuration to another.

Table 20

Student Costs

Student Position and Rank/Rate	15-year Student Load	Cost Per Year Per Student	Percent of Year in P-3 Training	Total
Pilot (1st tour) (Ensign)	2250	$35,770	40%	$ 32,193,000
Pilot (2nd Tour) (LCDR)	450	85,920	34%	13,146,000
NFO (Ensign)	1800	29,930	38%	20,472,000
FE (AD3)	2100	16,277	40%	13,672,000
SS-1/2 (AW3)	1800	20,680	31%	11,540,000
SS-3 (AW3)	900	20,233	24%	4,370,000
Ordnance (AO3)	1800	15,869	13%	3,713,000
Communicator (AT3)	600	31,684	26%	4,942,000
Total				$104,048,000

Table 21

Total P-3 Aircrew Training Costs

Cost Category	Procurement Cost	15-year Personnel Cost	15-year Nonpersonnel Cost	Total
ISD Costs	$ 3,981,000	$ 2,967,000	--[a]	$ 6,948,000
Facilities	600,000	9,015,000	900,000	10,515,000
Training Devices	28,200,000	26,041,000	--[a]	54,241,000
AET Costs	--[a]	16,445,000	523,629,000	540,074,000
Student Costs	N.A.	104,048,000	N.A.	104,048,000
Total	$32,781,000	$158,516,000	$524,529,000	$715,826,000

[a]Costs in these categories were excluded from consideration or covered in another category in this application of the cost assessment model.

Figure 2 shows the complete cost model as it has been applied to P-3 FRS aircrew training.

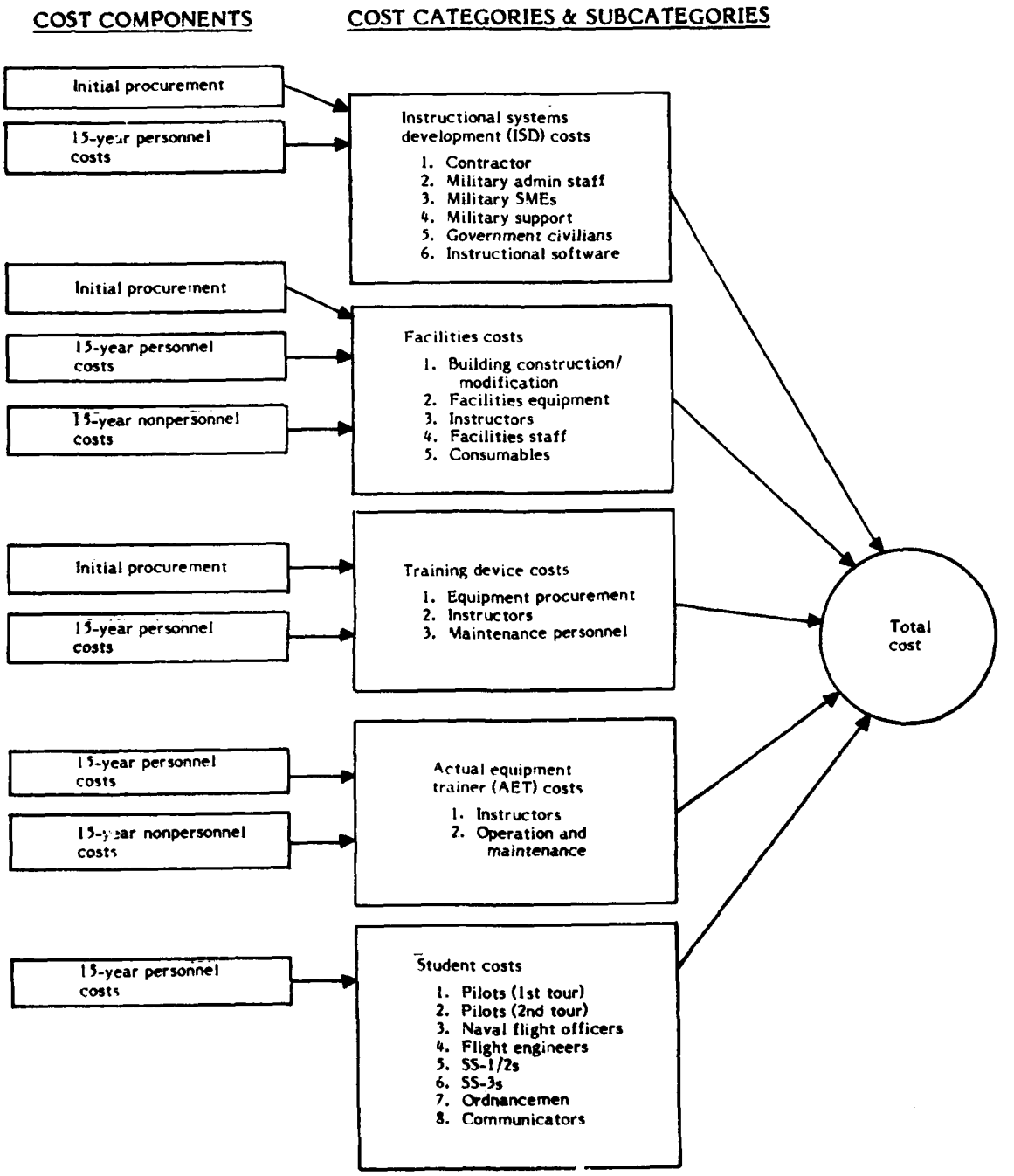

Figure 2. P-3 FRS aircrew training system cost model.

DISCUSSION

Once the cost model has been applied, a considerable body of data is available for examination and comparison with other training system cost data. The following discussion is not intended to be complete in its coverage of all possible implications of P-3 FRS aircrew training costs, but is illustrative of the kinds of comparisons that can be made.

Internal System Cost Comparisons

A summary of the P-3 FRS aircrew training system component cost figures and the cost of each component relative to the total cost is shown in Table 22.

Table 22

Relative Costs of Major Training System Categories

Training System Category	Cost	% of Total Cost
ISD	$ 6,948,000	1.0%
Facilities	10,515,000	1.5%
Training Devices	54,241,000	7.6%
AET	540,074,000	75.4%
Students	104,048,000	14.5%
Total	$715,826,000	100.0%

One notable comparison is that the costs of P-3 ISD activities are minor when compared to the total cost of P-3 FRS aircrew training. This is true even though their impact on overall costs can be significant, since the use of ISD techniques may make substantial reductions in cost possible in other categories.

At over 75 percent, the costs attributable to AET are a substantial percentage of the total costs. Even so, the percentage of the total would have been greater if some of the costs in this category had not been ignored for the reasons noted. Costs would be relatively high in this category no matter what the configuration of the training system. Of interest here also would be the relative equipment costs if alternative training system configurations were priced and examined. Obviously, with the bulk of the cost centered in this category, the opportunity for savings is greatest here. If even a small reduction in the number of flight hours required by the syllabus can be achieved, the savings could be enormous.

Similarly, the costs associated with training devices are, at 7.6 percent, somewhat lower than they would be if all possible training device costs were included. Since overall training device costs are much less than aircraft-related costs, potential savings would be less dramatic but still significant. In fact, cost savings may be more easily realizable in areas that do not have such a high overall cost as AET. In training systems requiring AET

assets, a given level of AET is probably required in any system configuration, whereas the development of, and capabilities required in, a training device may vary considerably depending on the degree and nature of the training need. With careful front-end analysis, it may be possible to design into training devices only those capabilities required for training and, thereby, reduce costs substantially.

A surprising finding is the high cost of students. Although student costs are minor in comparison with AET costs, they comprise the second largest cost category. If a 15-year life cycle is assumed, as here, student-related costs are nearly 15 percent of the total. In a training system with less expensive AET requirements, the costs associated with students are likely to comprise the largest single cost category. This area, too, may be more amenable to cost reductions than some others as a result of careful application of ISD techniques. In the P-3 FRS aircrew training system, any effort that can be focused toward reducing student-related costs, or conversely to increase the number of students trained during the system's life cycle, would seem to be warranted.

The primary way in which a reduction of student-related costs could occur would seem to be the reduction in length of various parts of the P-3 MCS. This, of course, would have to occur without any deletion of the critical content being taught. If any savings in MCS time can be realized, a significant dollar savings is possible. One small example should suffice to illustrate this point. If the current MCS first-tour pilot syllabus were reduced in length from 99 to 98 days, with no other change in the training system, the life-cycle cost savings would amount to over $125,000.

When the existing P-3 FRS MCS was developed, little emphasis was placed on the reduction of course length. If overall cost savings are deemed a worthwhile goal, an effort aimed at making the subject matter more compact and efficient, and thereby reducing MCS length, would be worth a sizable investment.

The other costly areas of the P-3 FRS aircrew training system involve equipment and the personnel who use the equipment, both training devices and aircraft. The two nearly equal components of that cost are initial procurement of the training devices, and the more significant costs attributable to personnel who maintain and instruct using both training devices and aircraft. Instructional science has evolved to the point where input into both of these areas can reap cost savings.

Often in the past, training device design has occurred without due consideration of purely instructional requirements. In some cases, devices are built with an eye toward making them as "realistic" as possible, partly because a need is felt for ensuring that all critical training attributes are addressed. Unfortunately, adequate techniques were not previously available to allow the selection of these attributes. To the extent that designers can now specify these attributes and design training devices accordingly, savings are possible in both initial procurement costs and in instructor and maintenance personnel requirements.

The likelihood that cost reductions can be realized by reductions in the amount of equipment used is less in the case of an existing complement of AET than when new AET is being purchased. In the case of a P-3 FRS, the tendency will be to continue the dependence on the available resource of P-3 aircraft to a great extent. However, if it were feasible to substitute properly designed training devices and other instructional events for some of the training activities that now occur on the aircraft, a very significant savings in overall training costs would be possible.

If a completely new training system is being developed, the situation is somewhat different. Specification of instructional events from scratch, with no preconceived needs or existing training structure, could occur in such a way that a much less costly system could result. Some efforts to do this with emerging weapon systems are underway, for example, in the case of training analysis for the proposed replacement Navy pilot trainer aircraft, the VTX.

Unit Costs

A number of specific cost figures are calculable, once the mass of data given in the preceding pages has been collected. Examples include:

1. Average cost per student. The total LCC for P-3 FRS aircrew training ($715,826,000) can be divided by the total number of students in the life cycle (11,700) to obtain the average cost per student ($61,182).

2. Average life-cycle cost per hour of instruction. The total life-cycle ISD cost ($6,948,000) can be divided by the total number of hours of instruction (3,946) prepared to obtain the average life-cycle cost per hour of instruction ($1,760).

3. Average life-cycle cost per objective. The total life-cycle ISD cost ($6,948,000) can be divided by the total number of instructional objectives (5,722) to obtain the average life-cycle cost per objective ($1,214).

4. Average cost per crew. The average cost per student ($61,182) can be multiplied by the number of students per crew (9) to obtain the average cost per crew ($550,635).

It is clear that many other calculations are possible. For example, with the data at hand, it would be possible to determine the precise percentage of each cost area attributable to each course by using course length as a determinant, and thereby move beyond average student costs.

Utility of a Cost Model

The precise specification of a major weapon system's training support requirements is a complex process. The costs involved are not always clear to Navy planners or managers since they cross budgetary lines of control. It is hoped that a model such as the one presented here can assist planners in estimating the relative impact that component costs can have on the total costs of training. A model such as this, that is specifically tailored for collection of data in order to support decision making in fleet level units, seems to be warranted.

This report provides a model for assessing the potential costs of training system alternatives. The relative benefits of cost decisions can also be examined but is beyond the scope of this report. The model presented here discusses only the cost side of a more complete costs/benefits model.

Changes in training system components can have unexpected effects on cost. Revisions in one category may cause significant changes in another. For example, a major aircraft system change could cause a revision of all training involving that system, including classroom syllabus components, facilities, training device/simulator training and equipment modifications, and possible changes in student on-board requirements. It is conceivable that new facilities or training devices might be required. If all possible changes and their accompanying costs can be anticipated and included in early planning,

the full ramifications of the changes can be understood so that sufficient funding can be identified to properly modify the training system. Alternatively, on the basis of more complete information, it may be decided that the proposed modification is not cost effective, given the total cost of its implementation.

It is important that training managers understand how a change may generate a host of downstream changes affecting the total system. If information can be provided that will allow accurate projection of the costs of new or revised training system components, better informed training system management decisions will result.

CONCLUSIONS

1. This model or a similar one appears to be useful in accounting for and/or planning for relative training costs in a complex weapon system.

2. It appears that cost savings can result when cost considerations are examined during the revision of a training system.

3. The model can be applied both to the development of new training systems and the revision of existing systems.

4. The ISD costs involved in a complex training system are relatively minor in comparison to other costs that are not usually considered in training system revision.

RECOMMENDATIONS

1. Relative cost determinations such as those illustrated for the P-3 FRS aircrew training system should be carried out prior to the acquisition of a new training system or the revision of an existing training system.

2. If the model presented in this report is applied by other users, the results of the application should be made available to this Center (Code P14) to facilitate revision of the model.

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